

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 2, 2018 / 2019

**PPH0125 - MECHANICS**

(Foundation in Engineering)

4 MARCH 2019  
2.30 p.m. – 4.30 p.m.  
(2 Hours)

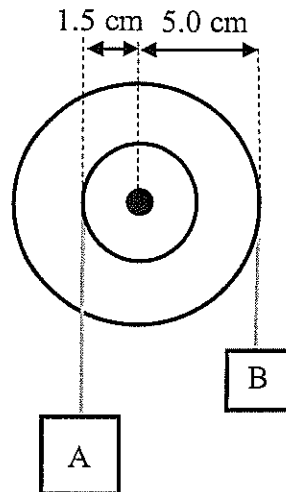
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### INSTRUCTIONS TO STUDENT

1. This question paper consists of **FOUR** printed pages, excluding the cover page and appendices, with **FIVE** questions.
2. Answer all questions. The distribution of the marks for each question is given.
3. Write all your answers in the answer booklet provided.
4. All necessary workings must be shown.

**QUESTION 1 (10 marks)**

- a) Given  $\mathbf{P} = 5\mathbf{i} + 3\mathbf{j} - \mathbf{k}$  and  $\mathbf{Q} = 3\mathbf{i} - \mathbf{j} - 2\mathbf{k}$ . Determine the cross product of  $\mathbf{P} \times \mathbf{Q}$ . (2 marks)
- b) A vehicle starts from rest with a uniform acceleration and in 10.0 s has moved a distance of 150.0 m.
- i. What is the acceleration of the vehicle? (1 mark)
- ii. What is its speed at  $t = 10.0$  s? (1 mark)
- c) A person stands on a scale in an elevator at rest on the 35<sup>th</sup> floor of a building. The scale reads 784 N. As the elevator moves up, the scale reading increases to 850 N. What is the acceleration of the elevator? (2 marks)
- d) Two objects ( $A$  and  $B$ ) hang stationary from strings going around pulleys of different diameters as shown in **Figure Q1.1**. If mass of object  $B$  is 0.6 kg, determine the mass of object  $A$ . (2 marks)

**Figure Q1.1****Continued...**

- e) The box in **Figure Q1.2** is being pushed up the ramp with a force of 50.0 N. If the 50.0 N force is parallel with the ramp, what is the work done by the force? (2 marks)

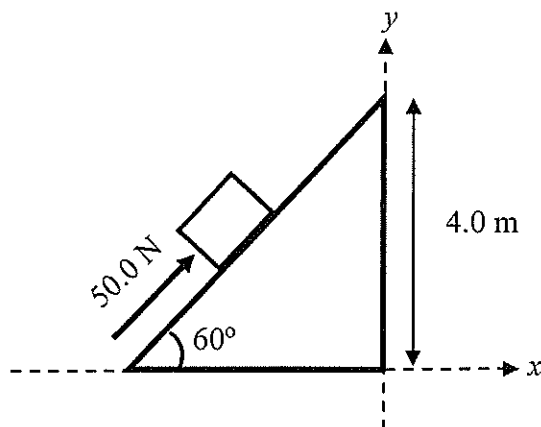


Figure Q1.2

**QUESTION 2 (10 marks)**

- a) In a diving competition, a diver performs 2.5 somersaults in 1.6 s. What is the average angular speed of the diver in rad/s? (2 marks)
- b) A flywheel has a constant angular deceleration of 2.2 rad/s.  
 i. Find the angle through which the flywheel turns as it comes to rest from angular speed of 210.0 rad/s. (2 marks)  
 ii. What is the time required for the flywheel to come to rest? (2 marks)
- c) A light thread with a block of mass  $m = 0.6$  kg tied to its end is wound on a wheel of radius  $R = 0.4$  m as shown in **Figure Q2.1**. The moment of inertia of the wheel,  $I = 1.1 \times 10^{-1}$  kg.m<sup>2</sup>, and the axis of the wheel is frictionless. If the block is released from rest, find its speed just before it hits the floor. (4 marks)

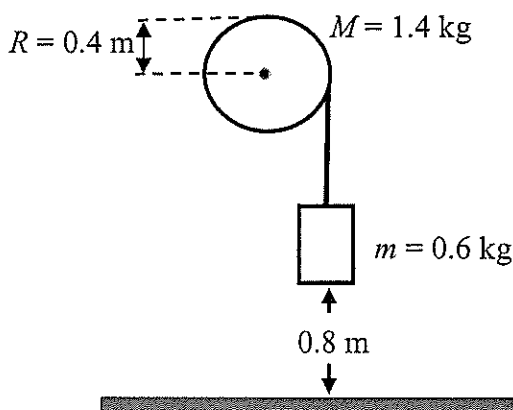
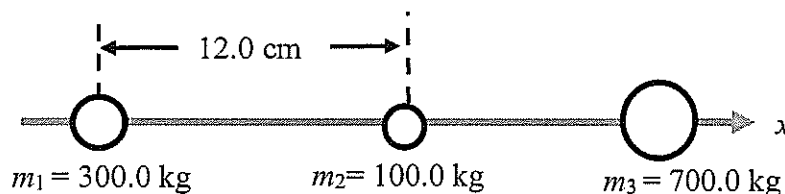


Figure Q2.1

Continued...

**QUESTION 3 (10 marks)**

- a) Three masses are placed on  $x$ -axis shown in **Figure Q3.1**. If the net gravitational force acting on  $m_2$  due to the other two masses is zero, find the distance between  $m_2$  and  $m_3$ . (3 marks)

**Figure Q3.1**

- b) A satellite of mass  $500.0 \text{ kg}$  orbiting the Earth at an altitude of  $2.0 \times 10^5 \text{ m}$ .
- Calculate the potential energy of the satellite-Earth system. (2 marks)
  - If the satellite orbiting the Earth in a circle, calculate the tangential speed of the satellite. (2 marks)
  - What is period of the satellite orbiting the Earth? (3 marks)

**QUESTION 4 (10 marks)**

- a) A  $90.0\text{-kg}$  metal cylinder with a length of  $0.5 \text{ m}$  and each end of area  $7.5 \times 10^{-3} \text{ m}^2$  is placed vertically on one end on a floor. What pressure does the cylinder exert on the floor? (2 marks)
- b) A  $200.0\text{-kg}$  load is hung on a wire with an original length of  $0.3 \text{ m}$ , cross sectional area of  $7.9 \times 10^{-5} \text{ m}^2$ , and Young's modulus of  $7.7 \times 10^8 \text{ N/m}^2$ . Calculate the extension of the wire. (3 marks)
- c) A plastic sphere floats in water with  $50.0\%$  of its volume submerged. The same sphere floats in oil of density  $1430.0 \text{ kg/m}^3$  with part of its volume submerged.
- Determine the density of the plastic sphere. (3 marks)
  - Find the percentage of the volume of the sphere that submerged in the oil. (2 marks)

**Continued...**

**QUESTION 5 (10 marks)**

- a) A block of mass 3.0 kg is suspended from a fixed point by means of a spring of original length 1.2 m and spring constant  $k = 42.0 \text{ N/m}$ .

i. Find the length of the spring when the block rests in equilibrium.

(3 marks)

The block is then pulled down until the spring stretches to length of 2.2 m, and is released so that the block oscillates in simple harmonic motion.

ii. Calculate the period of the oscillation.

(2 marks)

iii. What is the amplitude of the oscillation?

(1 mark)

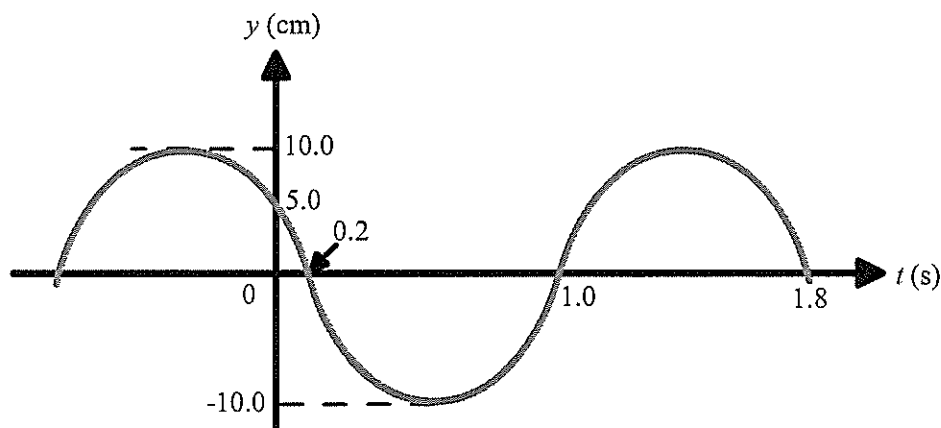
- b) **Figure Q5.1** shows a graph of displacement versus time for a simple harmonic motion. Based on the graph, find:

i. Frequency.

(2 marks)

ii. If the equation that representing the motion is written as  $y = A \cos(\omega t + \phi)$ , find  $\phi$ .

(2 marks)



**Figure Q5.1**

**End of page**

## APPENDIX I

### Physical Constants

Quantity	Symbol	Value
Electron mass	$m_e$	$9.11 \times 10^{-31} \text{ kg}$
Proton mass,	$m_p$	$1.67 \times 10^{-27} \text{ kg}$
Elementary charge	$e$	$1.602 \times 10^{-19} \text{ C}$
Gravitational constant	$G$	$6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$
Gas constant	$R$	$8.314 \text{ J/K.mol}$
Hydrogen ground state	$E_o$	$-13.6 \text{ eV}$
Boltzmann's constant	$k_B$	$1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength	$\lambda_c$	$2.426 \times 10^{-12} \text{ m}$
Planck's constant	$h$	$6.626 \times 10^{-34} \text{ J.s}$
Speed of light in vacuum	$c$	$3.0 \times 10^8 \text{ m/s}$
Rydberg constant	$R_H$	$1.097 \times 10^7 \text{ m}^{-1}$
Acceleration due to gravity,	$g$	$9.8 \text{ m/s}^2$
Atomic mass unit (1u)	$u$	$1.66 \times 10^{-27} \text{ kg}$
Avogadro's number	$N_A$	$6.023 \times 10^{23} \text{ mol}^{-1}$
Threshold of intensity of hearing	$I_o$	$1.0 \times 10^{-12} \text{ W/m}^2$
Coulomb constant	$k$	$9.0 \times 10^9 \text{ N.m}^2/\text{C}^2$
Permittivity of free space	$\epsilon_o/\kappa_o$	$8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$
Permeability of free space	$\mu_o$	$4\pi \times 10^{-7} \text{ H/m}$

### Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	$9.8 \text{ m/s}^2$
Radius	=	$6.4 \times 10^6 \text{ m}$
Mass	=	$6.0 \times 10^{24} \text{ kg}$

Moon:

Mass	=	$7.4 \times 10^{22} \text{ kg}$
Radius	=	$1.7 \times 10^6 \text{ m}$

Sun:

Mass	=	$2.0 \times 10^{30} \text{ kg}$
Radius	=	$6.96 \times 10^8 \text{ m}$

Mean distance from:

Sun to Earth	=	$1.50 \times 10^{11} \text{ m}$
Moon to Earth	=	$3.85 \times 10^8 \text{ m}$

## APPENDIX II

### List of formulas

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$ $\sin \alpha + \sin \beta = 2 \cos \left( \frac{\alpha - \beta}{2} \right) \sin \left( \frac{\alpha + \beta}{2} \right)$ $\sin(\alpha - \beta) + \sin(\alpha + \beta) = 2 \sin \alpha \cos \beta$
$v = v_o + gt$ $y - y_o = \left( \frac{v_o + v}{2} \right) t$ $a_c = \frac{v^2}{r}$ $\tau = r \times F$ $v = r \omega$ $L = r \times p = I \omega$	$y - y_o = v_o t + \frac{1}{2} g t^2$ $v^2 = v_o^2 + 2g(y - y_o)$ $F_g = G \frac{m_1 m_2}{r^2}$ $U_g = -G \frac{m_1 m_2}{r}$ $T^2 = K_s r^3$ $\sum \tau = \tau_{net} = I \alpha$ $I = \sum m r^2$ $K = \frac{1}{2} I \omega^2$ $ \tau  =  r   F  \sin \theta$ $T_s = 2\pi \sqrt{\frac{m}{k}}$ $T_p = 2\pi \sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$ $\bar{y} = \frac{\sum_{i=1}^N m_i y_i}{\sum_{i=1}^N m_i}$ $x = A \cos \omega t$ $x = A \sin \omega t$ $v = -\omega A \sin \omega t$ $v = \omega A \cos \omega t$ $W_F =  r   F  \cos \theta$ $a = -\omega^2 A \cos \omega t$ $a = -\omega^2 A \sin \omega t$ $v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $v = v_o + at$ $x - x_o = v_o t + \frac{1}{2} a t^2$ $v^2 = v_o^2 + 2a(x - x_o)$ $x - x_o = \left( \frac{v_o + v}{2} \right) t$ $W = mg$ $\sum F = F_{net} = ma$ $f_s \leq \mu_s F_N$ $f_k = \mu_k F_N$ $p = mv$ $\sum F = \frac{\Delta p}{\Delta t}$ $\Sigma W = \frac{1}{2} m v^2 - \frac{1}{2} m u^2$ $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ $m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$ $P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F \bar{v}$ $K = \frac{1}{2} m v^2$ $PE_s = \frac{1}{2} k x^2$ $F_s = -kx$ $PE_g = mgy$ $\bar{x} = \frac{\sum_{i=1}^N m_i x_i}{\sum_{i=1}^N m_i}$ $W_{Fs} = \frac{1}{2} k x_i^2 - \frac{1}{2} k x_f^2$